with gold as such, it is combined with the whole group $AuCl_4$, a radicle that is doubtless far more chlorous than chlorine itself.

If any were inclined to doubt the truth of this view, they should write the formula $ClNH_4$ under $NaAuCl_4$, when they would perceive that the radicle $AuCl_4$ corresponded to NH_4, ammonium, the basylous properties of which no one doubted nowadays.

In ammonium we have the basylous energies of four hydrogen atoms concentrated by the inert nitrogen, and the result was a powerfully basylous radicle; in $AuCl_4$ we have the chlorous energies of four chlorine atoms giving a powerfully chlorous radicle.

Among other examples of the kind the Professor cited:

K_2AsF_7 with nonovalent atom.

$\left.\begin{array}{l} K_2PtCl_6 \\ K_2SiF_6 \end{array}\right\}$ with octovalent atoms.

$\left.\begin{array}{l} OI(OH)_5 \\ KSbF_6 \end{array}\right\}$ with heptavalent atoms.

$\left.\begin{array}{l} K_2FeF_4 \\ K_2MgBr_4 \\ K_2CuCl_4 \end{array}\right\}$ with hexavalent atoms.

$KMgCl_3$ with tetravalent atoms.

And he concluded his address by drawing attention to the conditions that affect the atomic value of an element, which he said were, firstly, the nature of the combining atoms: there was a limit to the number of atoms of one kind that can combine with a given element, but if the element combined at the same time with one or more atoms of a different character, this limit might be passed; and secondly, the temperature, a sufficient rise of temperature being always accompanied by a diminution of atomic value. He thought it of great importance that these points should be considered by those who had artificially limited their horizon. The properties of many of the atoms in complex substances having been in great measure concealed from view by the practice of giving specific names, such as the word "molecular," he thought it would be much better to say at once that we are ignorant of the constitution of these bodies than to resort to such names.

JURASSIC BIRDS AND THEIR ALLIES[1]

ABOUT twenty years ago two fossil animals of great interest were found in the lithographic slates of Bavaria. One was the skeleton of *Archæopteryx*, now in the British Museum, and the other was the *Compsognathus* preserved in the Royal Museum at Munich. A single feather, to which the name *Archæopteryx* was first applied by Von Meyer, had previously been discovered at the same locality. More recently another skeleton has been brought to light in the same beds, and is now in the Museum of Berlin. These three specimens of *Archæopteryx* are the only remains of this genus known, while of *Compsognathus* the original skeleton is, up to the present time, the only representative.

When these two animals were first discovered they were both considered to be reptiles by Wagner, who described *Compsognathus*, and this view has been held by various authors down to the present time. The best authorities, however, now agree with Owen that *Archæopteryx* is a bird, and that *Compsognathus*, as Gegenbaur and Huxley have shown, is a Dinosaurian reptile.

Having been engaged for several years in the investigation of American Mesozoic birds, it became important for me to study the European forms, and I have recently examined with some care the three known specimens of *Archæopteryx*. I have also studied in the Continental museums various fossil reptiles, including *Compsognathus*, which promised to throw light on the early forms of birds.

During my investigation of *Archæopteryx* I observed several characters of importance not previously determined, and I have thought it might be appropriate to present them here. The more important of these characters are as follows:—

1. The presence of true teeth, in position, in the skull.
2. Vertebræ biconcave.
3. A well-ossified broad sternum.
4. Three digits only in the manus, all with claws.
5. Pelvic bones separate.
6. The distal end of fibula in front of tibia.
7. Metatarsals separate, or imperfectly united.

These characters, taken in connection with the free metacarpals and long tail, previously described, show clearly that we have in *Archæopteryx* a most remarkable form, which, if a bird, as I believe, is certainly the most reptilian of birds.

If now we examine these various characters in detail, their importance will be apparent.

The teeth actually in position in the skull appear to be in the the premaxillary, as they are below or in front of the nasal aperture. The form of the teeth, both crown and root, is very similar to the teeth of *Hesperornis*. The fact that some teeth are scattered about near the jaw would suggest that they were implanted in a groove. No teeth are known from the lower jaw, but they were probably present.

The presacral vertebræ are all, or nearly all, biconcave, resembling those of *Ichthyornis* in general form, but without the large lateral foramina. There appear to be twenty-one presacral vertebræ, and the same, or nearly the same, number of caudals. The sacral vertebræ are fewer in number than in any known bird, those united together not exceeding five, and probably less.

The scapular arch strongly resembles that of modern birds. The articulation of the scapula and caracoid, and the latter with the sternum is characteristic; and the furculum is distinctly avian. The sternum is a single broad plate, well ossified. It probably supported a keel, but this is not exposed in the known specimens.

In the wing itself the main interest centres in the manus and its free metacarpals. In form and position these three bones are just what may be seen in some young birds of to-day. This is an important point, as it has been claimed that the hand of *Archæopteryx* is not at all avian, but reptilian. The bones of the reptile are indeed there, but they have already received the stamp of the bird.

One of the most interesting points determined during my investigation of *Archæopteryx* was the separate condition of the pelvic bones. In all other known adult birds, recent and extinct, the three pelvic elements—ilium, ischium, and pubis, are firmly anchylosed. In young birds these bones are separate, and in all known Dinosaurian reptiles they are also distinct.

In birds the fibula is usually incomplete below, but it may be co-ossified with the side of the tibia. In the typical Dinosaurs, *Iguanodon*, for example, the fibula at its distal end stands in front of the tibia, and this is exactly its position in *Archæopteryx*, an interesting point not before seen in birds.

The metatarsal bones of *Archæopteryx* show, on the outer face at least, deep grooves between the three elements, which imply that the latter are distinct, or unite late together. The free metacarpal and separate pelvic bones would also suggest distinct metatarsals, although they naturally would be placed closely together, so as to appear connate.

Among other points of interest in *Archæopteryx* may be mentioned the brain-cast, which shows that the brain, although comparatively small, was like that of a bird, and not that of a Dinosaurian reptile. It resembles in form the brain-cast of *Laopteryx*, an American Jurassic bird, which I have recently described. The brain of both these birds appears to have been of a somewhat higher grade than that of *Hesperornis*, but this may have been due to the fact that the latter was an aquatic form, while the Jurassic species were land birds.

As the *Dinosauria* are now generally considered the nearest allies to birds, it was interesting to find in those investigated many points of resemblance to the latter class. *Compsognathus*, for example, shows in its extremities a striking similarity to *Archæopteryx*. The three clawed digits of the manus correspond closely with those of that genus; although the bones are of different proportions. The hind feet also have essentially the same structure in both. The vertebræ, however, and the pelvic bones of *Compsognathus* differ materially from those of *Archæopteryx*, and the two forms are in reality widely separated. While examining the *Compsognathus* skeleton, I detected in the abdominal cavity the remains of a small reptile which had not been previously observed. The size and position of this inclosed skeleton would imply that it was a fœtus; but it may possibly have been the young of the same species, or an allied form, that had been swallowed. No similar instance is known among the Dinosaurs.

A point of resemblance of some importance between birds and Dinosuurs is the clavicle. All birds have those bones, but they have been considered wanting in Dinosaurs. Two speci-

[1] Read by Prof. O. C. Marsh before Section D, British Association, at York, September 2, 1881. Communicated by the Author.

mens of *Iguanodon* in the British Museum, however, show that these elements of the pectoral arch were present in that genus. Some other *Dinosauria* possess clavicles, but in several families of this sub-class, as I regard it, they appear to be wanting.

The nearest approach to birds now known would seem to be in the very small Dinosaurs from the American Jurassic. In some of these the separate bones of the skeleton cannot be distinguished with certainty from those of Jurassic birds, if the skull is wanting, and even in this part the resemblance is striking. Some of these diminutive Dinosaurs were perhaps arboreal in habit, and the difference between them and the birds that lived with them may have been at first mainly one of feathers, as I have shown in my Memoir on the *Odontornithes*, published during the past year.

It is an interesting fact that all the Jurassic birds known, both from Europe and America, are land birds, while all from the Cretaceous are aquatic forms. The four oldest known birds, moreover, differ more widely from each other than do any two recent birds. These facts show that we may hope for most important discoveries in the future, especially from the Triassic, which has as yet furnished no authentic trace of birds. For the primitive forms of this class we must evidently look to the Palæozoic.

SCIENTIFIC SERIALS

Journal of the Asiatic Society of Bengal, vol. l. part 2, No. 2 1881 (July 30), contains:—H. F. Blanford, F.R.S., on the relations of cloud and rainfall to temperature in India, and on the opposite variations of density in the higher and lower atmospheric strata, and description of a rain-gauge with evaporimeter for remote and secluded stations (plate 15).—J. Wood-Mason, on some insects belonging to the Rhopalocera from India and Burmah.—W. T. Blanford, F.R.S., on the Voles (Arvicola) of the Tibet Himalayas and Afghanistan (plates 1 and 2); and on *Myospalax fuscicapillus*, Blyth.

Gegenbaur's morphologisches Jahrbuch, vol. vii., part 2, 1881, contains—R. S. Bergh, on the organisation of the cilio-flagellate Infusoria; a phylogenetic study; plates 12–16. Contains diagnoses of the genera Ceratium, Dinophysis, Protoperidinium (nov. gen.), Peridinium, Protoceratium (nov. gen.), Diplosalis (nov. gen.), Glenodinium, Gymnodinium, Polykrikus, and Protocentrum, with descriptions of several species in each.—Dr. W. Pfitzner, on the minute structure of cell-nuclei.—Prof. Bischoff, on the third or lowermost frontal gyrus (Stirnwindung), and the inner upper lobulus-parietalis gyrus in the gorilla.

Zeitschrift für wissenschaftliche Zoologie, August, 1881 (vol. xxxvi. part 1), contains; Dr. H. Simroth, on locomotion and the organ of locomotion in *Cyclostoma elegans* and other indigenous land and freshwater mollusca (plate 1 and many woodcuts).—Dr. P. Stöhr, on the development of the skull in the Anura (plates 2 and 3).—Dr. A. Gruber, on division in the monothalamous rhizopods (plates 4 and 5).—F. Blockmann, on the development of *Neritina fluviatilis* (plates 6, 7, and 8).—Prof. W. Krause, on the human allantois (plate 9).

SOCIETIES AND ACADEMIES

MANCHESTER

Literary and Philosophical Society, October 4, 1881.—J. P. Joule, F.R.S., &c., in the chair.—On drops floating on the surface of water, by Prof. Osborne Reynolds, F.R.S. It is well known that under certain circumstances drops of water may be seen floating on the surface for some seconds before they disappear. Sometimes during a shower of rain these drops are seen on the surface of a pond, they are also often seen at the bows of a boat when travelling sufficiently fast to throw up a spray. Attempts have been made to explain this phenomenon, but I am not aware of any experiments to determine the circumstances under which these drops are suspended. Having been deeply engaged in the experimental study of the phenomena of the surface-tension of water and the effect of the scum formed by oil or other substances, it occurred to me that the comparative rarity of these floating drops would be explained if it could be shown that they required a pure surface, a surface free from scum of any kind. For, owing to the high surface-tension of pure water, its surface is rarely free from scum. The surface of stagnant water is practically never free except when the scum is driven off by wind. But almost any disturbance in the water, such as the motion of a point of a stick round and round in the water, or water splashed on the surface, will serve to drive back the scum for a certain distance. This may be shown by scattering some flowers of sulphur on the surface. This powder is insoluble and produces no scum, and hence it serves admirably to show the motion of the surface and whatever scum there may be upon it. If when the surface is so dusted a splash be made by a stick so as to throw drops on to the sulphured surface, at the first splash no floating drops are produced; but after two or three splashes in rapid succession it will be seen that the sulphured scum has been driven back by the falling water, leaving a patch of clear surface, and on this drops will float in large numbers and of all sizes. These drops are entirely confined to that portion of the surface which is clear. The drops, either by their initial motion or by the current of air, glide rapidly over the surface from the point at which they are formed. When, however, they reach the edge of the scum they disappear, apparently somewhat gradually. I have this summer made the experiment on several ponds and on various days, and I have never found any difference. Any scum, however transparent, prevented the drops, and they always floated in large numbers when the scum was driven back in the manner described, by the wind or any other way. This result points to the conclusion that whatever may be the cause of this suspension, it depends only on the surface of the water being pure, and not at all on the temperature or condition of the air.—On the mean intensity of light that has passed through absorbing media, by James Bottomley, D.Sc., F.C.S.—Note on the colour relations of nickel, cobalt, and copper, by James Bottomley, D.Sc., F.C.S.

VIENNA

Imperial Academy of Sciences, October 13.—V. Burg in the chair.—The following papers were read:—A. v. Liebenberg, experiments on the part of lime in germination.—E. Weiss, computation of the elements and ephemeris of Barnard's comet.—E. Brücke, on some consequences of the Young-Helmholtz theory.—T. W. Brühl, on the connection between the optic and thermic properties of liquid organic bodies.

PARIS

Academy of Sciences, October 17.—M. Wurtz in the chair.—The Secretary presented the instructions formulated by the International Conference for Observation of the Transit of Venus.—Crystalline sulphurated copper (*cupréine*), formed at expense of old coins, apart from thermal springs, at Flines-les-Roches, Departement du Nord, by M. Daubrée.—Observations of the comet *b* 1881 (Tebbutt-Gould-Cruls) at Paris Observatory, by M. Bigourdan.—On a remarkable configuration of circles in space, by M. Stephanos.—On Fuchsian functions, by M. Poincaré.—On an experimental peculiarity relative to the equipotential law of Nobili's rings, by M. Guébhard. He has studied, under strong light, the trajectories of minute bubbles between electrodes in badly-conducting liquids; these are quite determinate and independent of gravity, and (friction and agitation of the liquid apart) seem to represent lines of force of the electric flow. With variously formed electrodes he has repeated Antolik's and Mach's experiments made with static discharge; and profiting by certain effects of polarisation, and counter-currents arising on quick reversal of the principal current, has obtained a fixed trace of the lines of flow.—Theory of a rapid vessel, by M. Pictet.—On the currents generated by atmospheric electricity and earth-currents, by M. Landerer. At Tortosa he stretched a wire between the roofs of two houses in a direction making a small angle with the magnetic meridian, and connected it with the water-pipes. The currents generated are variously due to condensation of aqueous vapour, to lightning-discharges, to action of wind, and to earth-currents. The first two and the fourth affect a telephone in the circuit, but not the third (these, however, as well as the second and fourth, deflect a galvanometer). The earth-currents are distinguished from atmospheric currents by their regularity and continuity during pretty long intervals. Variation of the earth-current is a sign of change of weather.—Action of sulphur on alkaline sulphides in very dilute solution, by M. Filhol. In such action on dilute solutions of monosulphide of sodium a polysulphide is formed, without notable production of hyposulphite, and it seems as though the original monosulphide has subsisted, spite of the dilution. But more probably it is decomposed and reconstituted.—On a new series of bases derived from morphine, by M. Grimaux.—On a new alkaloid of quinquinas, by M. Arnaud. The formula adopted for *cinchonamine* (this new alkaloid) is